OMRON

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Thermac Simulator

Operation Manual

H190-E1-01

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Introduction

Overview

The Thermac Simulator is a software application that simulates temperature control for E5□C-series Temperature Controllers.

Features

Adjusting parameters for a Temperature Controller can require extensive time because the equipment has to be operated and the control results have to be checked. The Thermac Simulator, however, allows you to simulate equipment temperatures on a computer, so that adjustment results can be checked immediately without operating the equipment.
With just the Thermac Simulator, you can perform everything from parameter settings and log data collection through the actual simulations.
Functions are also provided to allow you to easily adjust the parameters, such as automatic optimal differential time (D) adjustment and simulation results comparison before and after adjustment.

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This Agreement shall come into effect on the day first above written and remain valid for one (1) year thereafter. Unless either party notifies the other party of its intention not to renew this Agreement at least thirty (30) days prior to the expiration of then current term, this Agreement shall be automatically renewed and remain valid for a successive period of one (1) year thereafter each. If User breaches this Agreement, OMRON may terminate this Agreement upon notice to User. When this Agreement is expired or terminated, User shall promptly return or destroy the Software, Confidential Information and all copies thereof. The rights and obligations under Section 4, 5, 6, 8, 9, 10, 11 and 12 shall survive expiration or termination of this Agreement and bind the parties and their legal representatives, successors and assigns thereafter.

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Precautions for Safe Use

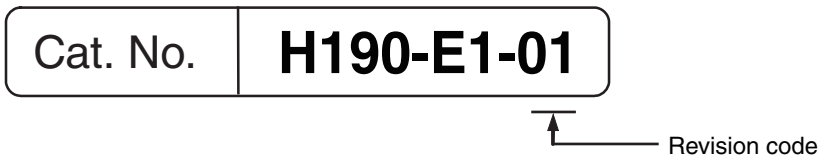
- In addition to this manual, also refer to the Instruction Manual and User's Manual for the Temperature Controller.
- Check the destination Temperature Controller before you transfer the parameters to it.
- Occasionally there are large deviations in the simulation waveforms. When you perform actual temperature control, always implement measures to ensure safety for unexpected temperature increases.

Precautions for Correct Use

- Use the Thermac Simulator only on the specified operating system. The Thermac Simulator may malfunction on other operating systems.
- Do not use the Thermac Simulator near motors, power lines, or other sources of electrical noise. Noise may enter on communications cables, possibly causing malfunctions.
- Do not run any other software applications while you are using the Thermac Simulator. Doing so may cause log data sampling to be skipped during communications with the Temperature Controller or other communications errors may occur.

Revision History

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.



Revision code	Date	Revised content
01	July 2014	Original production

Related Manuals

Refer to the *E5□C Digital Temperature Controller User's Manual* (Cat. No. H174) for information on the Temperature Controller and to the Instruction Manual that comes with the Temperature Controller for information on the USB-Serial Conversion Cable.

1 Introduction

1-1 Conditions for Use

System Requirements

The following system requirements must be met to use the Thermac Simulator.

Item	Specification
OS	Microsoft Windows 7, 32-bit edition
Processor	1 GHz min., 32-bit (x86) or better processor
RAM	1 GB min.
Hard disk space	16 GB or more available space
CD-ROM drive	1 drive min.
Monitor	XGA (1,024 × 768), 16-bit high color or better
Communications port	1 USB port min.

Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

Conditions for Use

The following conditions must be met to use the Thermac Simulator.

Applicable Controllers	E5□C-series Temperature Controllers except for Position-proportional and Programmable Models
Temperature Controller settings	1. The Thermac Simulator cannot be used with any of the following settings. • Input Type: 25 to 29 (analog input)*1 • PID·ON/OFF: ON/OFF • Standard/Heating-Cooling: Heating-Cooling • ST: ON • Direct/Reverse Operation: Direct operation • Event Input 1 to 6 Assignments: Anything other than "NONE"*2, *3 *1 Correct simulation results may not be possible if an Infrared Temperature Sensor is used. *2 If you change the event input assignment settings to "NONE" to use the Thermac Simulator, be sure to return them to the original settings when you are done using the Thermac Simulator. *3 If a work bit is set as an internal event in the logic operation settings, set the event input assignment to anything except Communications Writing Enable/Disable, RUN/STOP, or 100% AT Execute/Cancel. 2. For a Temperature Controller with a position-proportional output, temperature fluctuations may occur depending on the control period setting. The Thermac Simulator cannot reproduce those temperature fluctuations in a simulation. 3. A model cannot be created correctly if the MV Upper Limit or MV Lower Limit parameter is set to between –5.0% and –0.1% or between 100.1% and 105.0%. Set the MV Upper Limit parameter of the Temperature Controller to between 0.1% and 100.0% and the MV Lower Limit parameter to between 0.0% and 99.9%. 4. The following parameters are not used in simulations. The default settings of the Temperature Controller are used by the Thermac Simulator for these parameters. • Minimum Output ON/OFF Band: 1.0% • MV Change Rate Limit: 0.0%/s 5. It may not be possible to create a correct model for devices for which the manipulated variable increases gradually during temperature rise due to SP ramp settings with a small slope.

Controlled Devices	For the following controlled devices, there will be a large temperature deviation between a simulation and the actual Temperature Controller. Therefore the Thermac Simulator cannot be used for them. • Heaters for which there is a large change in the resistance depending on the temperature • Devices for which boiling or melting occurs • Cooling devices that use direct operation • Devices for which there is high thermal interference • Devices that reach the set point in 10 s or less • Devices that have a set point near room temperature

Applicable Log Files from Other Companies

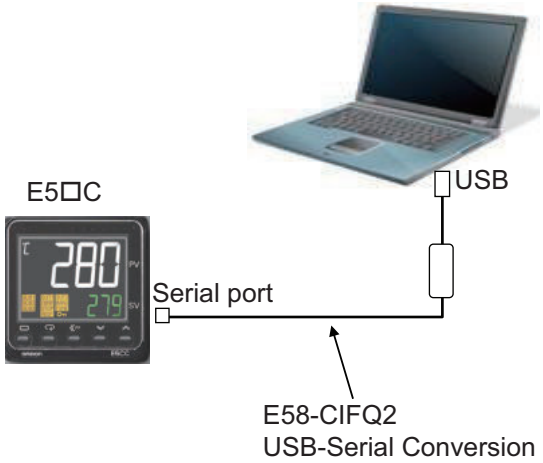
The Thermac Simulator can read log files created by the following software applications.

Temperature Controllers	Application
SDC15/25/26 (Azbil Corporation)	SLP-C35 Smart Loader Package
RB□00 (RKC Instrument Inc.)	PROTEM2

Company names and product names in this document are the trademarks or registered trademarks of their respective companies.

1-2 Connecting to the Temperature Controller with a USB-Serial Conversion Cable

To collect log data from the Temperature Controller, connect the Temperature Controller to the computer with an E58-CIFQ2 USB-Serial Conversion Cable. The E58-CIFQ2-E is required to connect to the Setup Tool port on the front panel of the E5EC, E5AC, or E5DC, or to connect to the Setup Tool port on the bottom panel of the E5GC.
For details on connecting the Temperature Controller to the computer with an E58-CIFQ2 USB-Serial Conversion Cable, refer to the *E5□C Digital Temperature Controllers User's Manual* (Cat. No. H174).



You must install a driver for the cable in the computer. If you are using the CX-Thermo, then the driver installation procedure is not required.
Use the following procedure to install the driver.

1 **Connect a USB port on the computer with a Setup Tool port on the Temperature Controller using the Cable.**

2 **Install the driver that comes with the Thermac Simulator.**

- Installation Procedure
  When the Cable is connected to the computer, the OS detects the product as a new device. When it is detected, install the driver using the Installation Wizard.

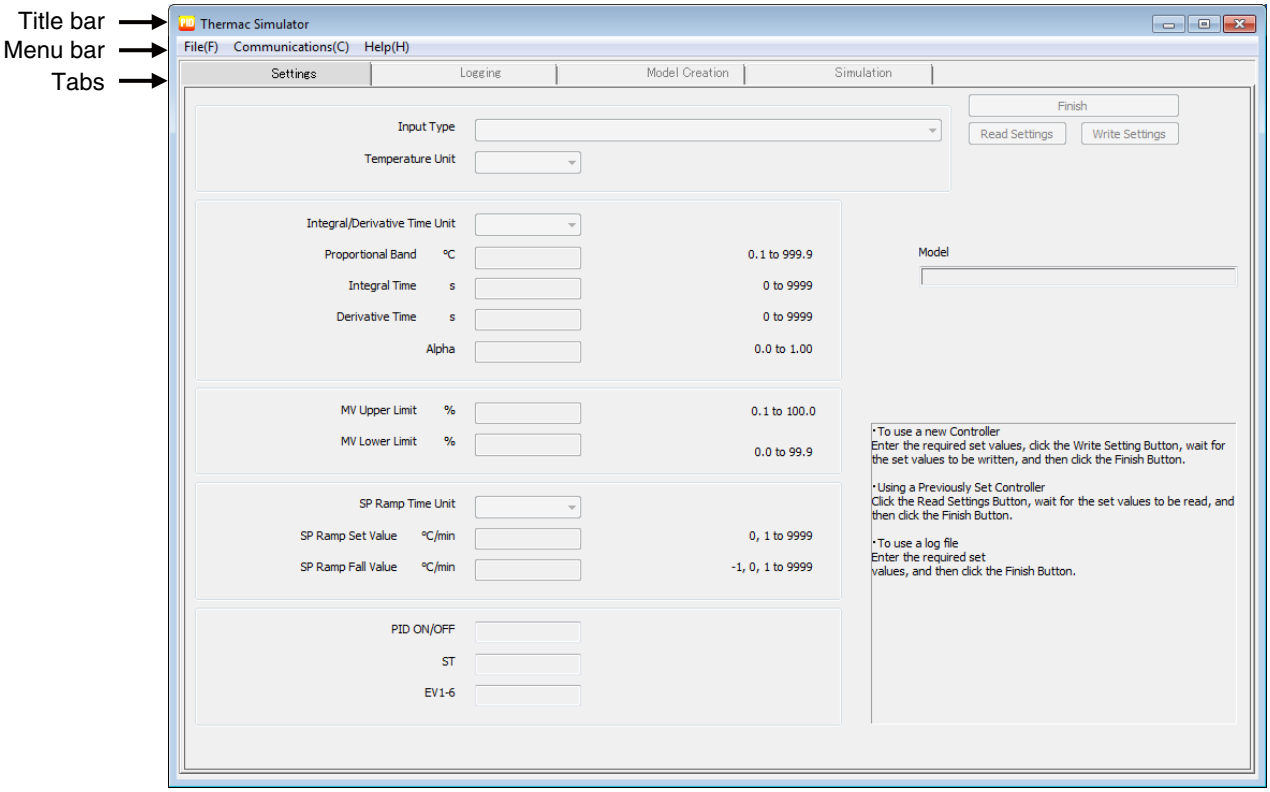
Note 1 We recommend that you install the driver for each USB port on the computer at the start.
The Temperature Controller assigns a COM port number to each USB port on the computer. If the same USB port is used, you will be able to use the same COM port number even if you use a different Cable.
2 Installation of the driver will not be completed if the installation is canceled before it is completed.
Normal communications will not be possible unless the driver is installed completely.
If the driver is not installed completely, uninstall it, and then install it correctly.

3 **Communications Condition Settings for the Setup Tool**

A COM port number is automatically assigned to the USB-Serial Conversion Cable.

2 Basic Thermac Simulator Operation

2-1 Part Names and Functions



- Title Bar

  The title bar displays the current project name.

- Menu Bar

  The menu bar provides the following menus and menu items.

Menu	Item	Description
File	New	Creates a new project.
	Open	Opens an existing project.
	Save	Overwrites the current project.
	Save As	Saves the current project under a different name.
	Exit	Exits the Thermac Simulator.
Communications	Port Settings	Used to select the serial port that is connected to the cable.
Help	Manual	Displays the manual.
	Version Information	Displays version information.

- Tabs

  The following tabs are provided.

Tab	Function
Settings	Used to set the Temperature Controller parameters required to log data.
Logging	Used to log data to use in creating a model.
Model Creation	Used to create a model of the controlled device from log data.
Simulation	Used to perform temperature waveform simulations based on a model.

2-2 Files

The Thermac Simulator creates the following files.
These files are saved in the following folder by default: C:\Users*user_name*\Documents\Thermac Simulator.

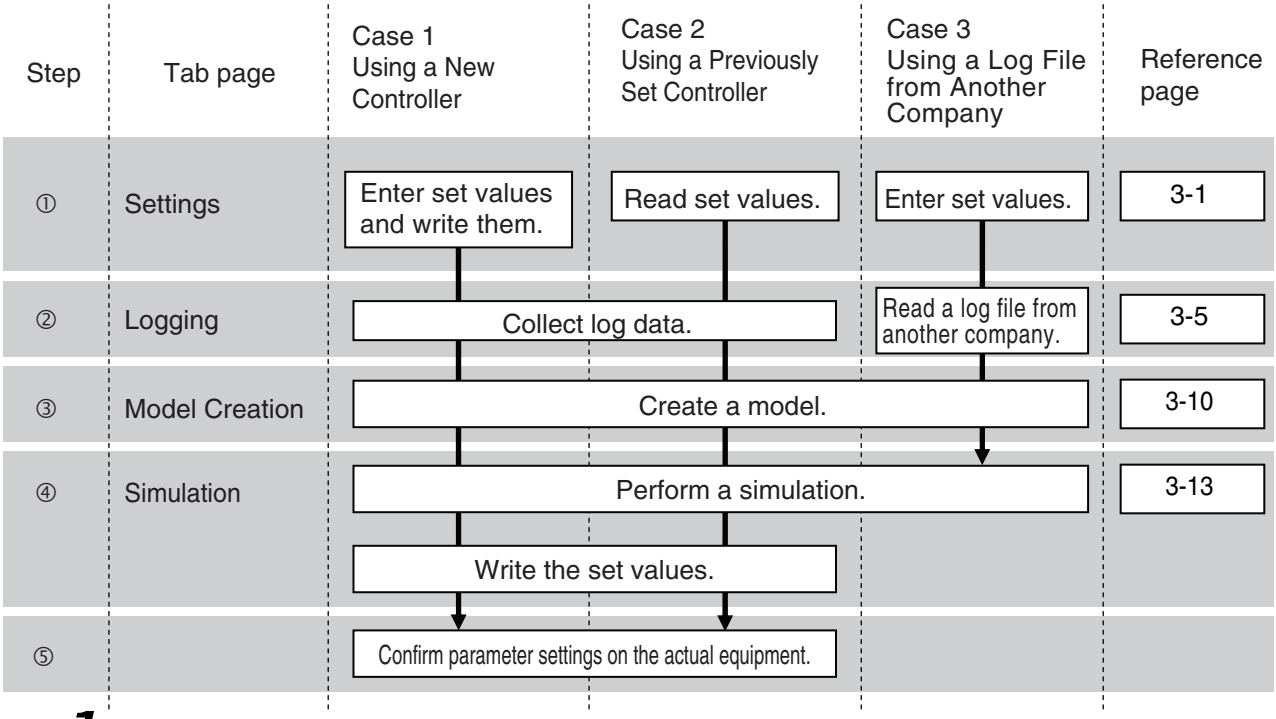
File name (default)	Description
PJ1.tcs	Project file
PJ1_Log_data.csv	CSV file of log data collected on the Logging Tab Page
PJ1_Sim_data.csv	CSV file of the simulation results calculated from the Simulation Tab Page.

Precautions for Correct Use

A “system” folder is automatically created in the following directory when you start the Thermac Simulator.
C:\Users*user_name*\Documents\Thermac Simulator\
The system uses this “system” folder. Do not delete it.

2-3 Basic Operations

There are the following three cases for operating the Thermac Simulator.



1 Start the Thermac Simulator.

Use the following procedure to start the Thermac Simulator.

- Starting from the Windows Start Menu.
  - (1) Select ***Programs*** – ***OMRON*** – ***Thermac Simulator*** – ***Thermac Simulator*** from the Windows Start Menu. The Thermac Simulator will start.
  - (2) Create or select a project.
    - Creating a New Project
      Select ***File*** – ***New***. A project will be created and operation will be enabled.
    - Selecting an Existing Project
      Select ***File*** – ***Open*** and then select a project.
- Starting from a Project File
  Double-click a project file (extension: tcs). The Thermac Simulator will be started.

2 Perform operations on the tab pages.

Perform operations in order on the tab pages: Settings, Logging, Model Creation, and Simulation. You cannot move to the next tab page until you complete the operations for each tab page. To return to previous tabs and make changes, save the project first and then repeat the operations on all tab pages starting from the tab page where the change is required. If you do not repeat the settings, disagreements will occur between the settings on different tab pages.
Refer to the description of each tab page for details.

3 Save the project.

Select ***File*** – ***Save As or File*** – ***Save***.

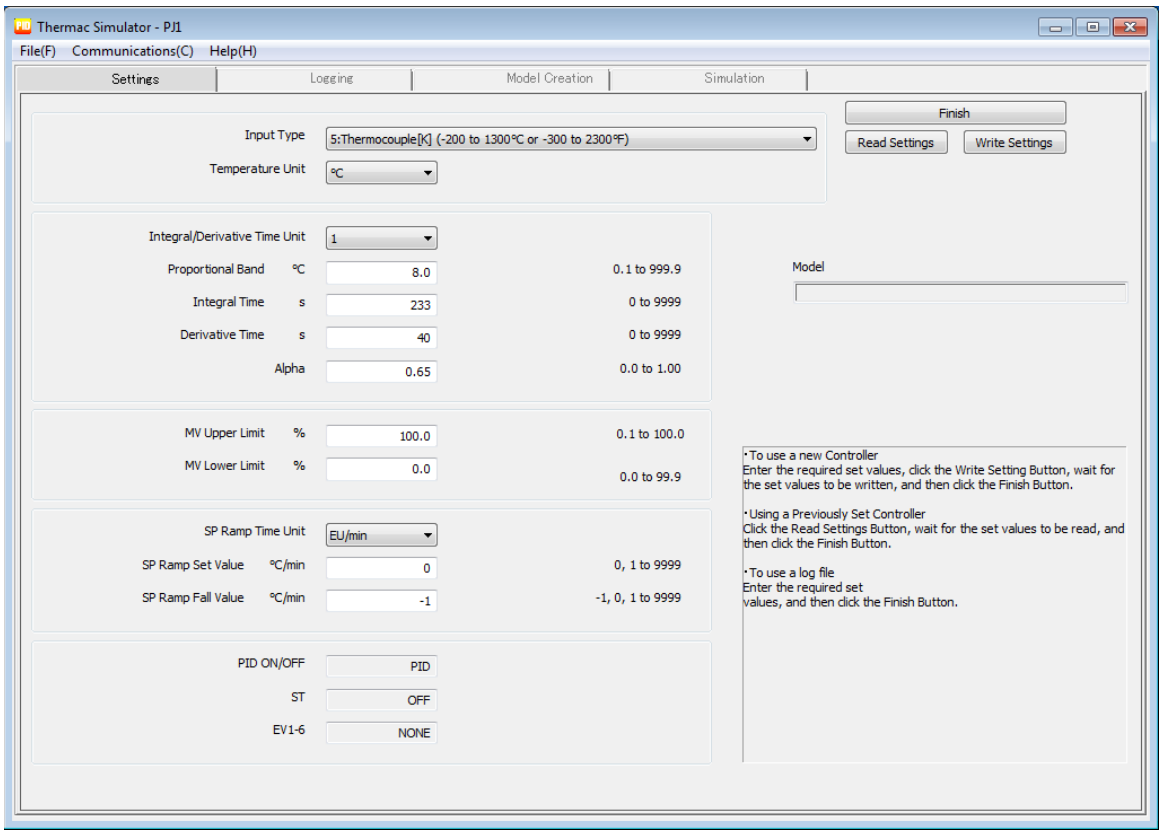
4 Exit the Thermac Simulator.

Select ***File*** – ***Exit***.

3 Operations on the Tab Pages

3-1 Settings Tab Page

This tab page is used to make the settings that are required for simulation.


Thermac Simulator - PJ1
File(F) Communications(C) Help(H)
Settings
Logging
Model Creation
Simulation
Finish
Input Type
5:Thermocouple[K] (-200 to 1300°C or -300 to 2300°F)
Temperature Unit
°C
Read Settings
Write Settings
Integral/Derivative Time Unit
1
Proportional Band °C 8.0 0.1 to 999.9
Integral Time s 233 0 to 9999
Derivative Time s 40 0 to 9999
Alpha 0.65 0.0 to 1.00
Model
MV Upper Limit % 100.0 0.1 to 100.0
MV Lower Limit % 0.0 0.0 to 99.9
SP Ramp Time Unit EU/min
SP Ramp Set Value °C/min 0 0, 1 to 9999
SP Ramp Fall Value °C/min -1 -1, 0, 1 to 9999
PID ON/OFF PID
ST OFF
EV1-6 NONE
•To use a new Controller
Enter the required set values, click the Write Setting Button, wait for the set values to be written, and then click the Finish Button.
•Using a Previously Set Controller
Click the Read Settings Button, wait for the set values to be read, and then click the Finish Button.
•To use a log file
Enter the required set values, and then click the Finish Button.

The setting procedure depends on how you will use the Thermac Simulator. There are the following three cases. The setting procedure for each case is given below.

Case 1: Using a New Controller

All settings are entered and the entered values are written to a Temperature Controller that has not yet been used.

Case 2: Using a Previously Set Controller

The settings are read from a Temperature Controller that has already been used.

Case 3: Using a Log File from Another Company

The settings are entered. Because there is already a log file, a Temperature Controller is not used.

3-1-1 Using a New Controller

Use the following procedure to set the parameters.

1 **Connect the Temperature Controller to the computer with a USB-Serial Conversion Cable.**

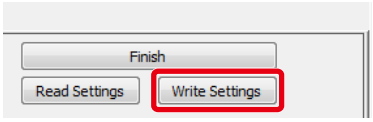
2 **Start the Thermac Simulator and create a new file.**

3 **Set the Input Type and Temperature Unit parameters.**

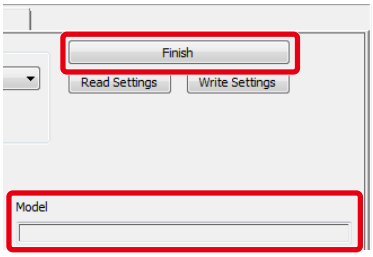
4 **If the PID constants were decided in advance, set the PID constants (i.e., the Proportional Band, Integral Time, and Derivative Time parameters).**
Leave the Integral/Derivative Time Unit and Alpha parameters at their default values.
If the setting of the Integral/Derivative Time Unit parameter is changed, the PID constants will be initialized. If you need to change this parameter, do so before you set the PID constants.

5 **Change the settings of the other parameters as required.**
The displayed values will be written for the PID·ON/OFF, ST, and Event Input 1 to 6 Assignment parameters.
If you change the setting of the Input Type parameter, the setting ranges for the SP Ramp Set Value and SP Ramp Fall Value parameters will also change. If you need to change the Input Type parameter, set it first. The following settings can be used.
You can set the SP Ramp Set Value or SP Ramp Fall Value parameter to 0 or 0.0 to disable the function.
You can set the SP Ramp Fall Value parameter to –1 or –0.1 to use the same set value as the SP Ramp Set Value parameter.

6 **Click the Write Settings Button to write the set values to the Temperature Controller.**
A confirmation message will be displayed. Click the **OK** Button.
If an error occurs, a message will be displayed. Follow the instructions given in the message.



7 **Check the model shown in the *Model* Box.**
After the set values are written to the Temperature Controller, the model of the Temperature Controller will be displayed in the *Model* Box.
Click the **Finish** Button to go to the Logging Tab Page.



3-1-2 Using a Previously Set Controller

Use the following procedure to set the parameters.

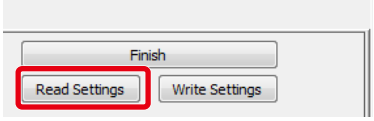
1 **Connect the Temperature Controller to the computer with a USB-Serial Conversion Cable.**

2 **Start the Thermac Simulator and create a new file.**

3 **Click the Read Settings Button to read the set values from the Temperature Controller.**

A confirmation message will be displayed. Click the **OK** Button.

If an error occurs, a message will be displayed. Follow the instructions given in the message.



Precautions for Correct Use

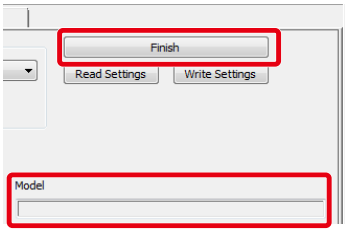
The Thermac Simulator cannot be used with any of the following settings. Change these settings temporarily if doing so will not adversely affect the control system.

Parameter name	Setting
Input Type	25 to 29 (analog input)
PID·ON/OFF	ON/OFF
Standard or Heating/Cooling	Heating/Cooling
ST	ON
Direct/Reverse Operation	Direct
Event Input 1 or 6 Assignments	Any setting except for “NONE”

4 **Check the model shown in the *Model* Box.**

After the set values are read from the Temperature Controller, the model of the Temperature Controller will be displayed in the *Model* Box.

Click the **Finish** Button to go to the Logging Tab Page.



3-1-3 Using a Log File from Another Company

Confirm that the Temperature Controller from which the log file was taken has the following settings or model. The Thermac Simulator cannot be used if these conditions are not met.

● SDC15/25/26 (Azbil Corporation)

Parameter	Setting
PV Input Range Type	1 to 68: Temperature
Control Method	1: Fixed PID
Heat/Cool Control	0: Disabled
Control Action (Direct/Reverse)	0: Heat control (reverse)

● RB□00 (RKC Instrument Inc.)

Model code: RB□00F①...

The □ in the model code is replaced by a number. The ① is replaced by a letter.

Use the following procedure to set the parameters.

1 **Start the Thermac Simulator and create a new file.**

2 **Use the following correlation table to set the parameters.**

Always set the Input Type parameter, Temperature Unit parameter, and PID constants (Proportional Band, Integral Time, and Derivative Time parameters).

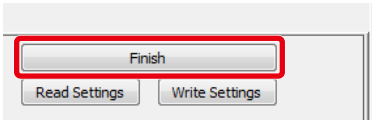
Set other parameters as required.

If you change the setting of the Input Type parameter, the setting ranges for the SP Ramp Set Value and SP Ramp Fall Value parameters will also change. If you need to change the Input Type parameter, set it first. The following settings can be used.

You can set the SP Ramp Set Value or SP Ramp Fall Value parameter to 0 or 0.0 to disable the function.

You can set the SP Ramp Fall Value parameter to −1 or −0.1 to use the same set value as the SP Ramp Set Value parameter.

3 **Click the Finish Button to go to the Logging Tab Page.**

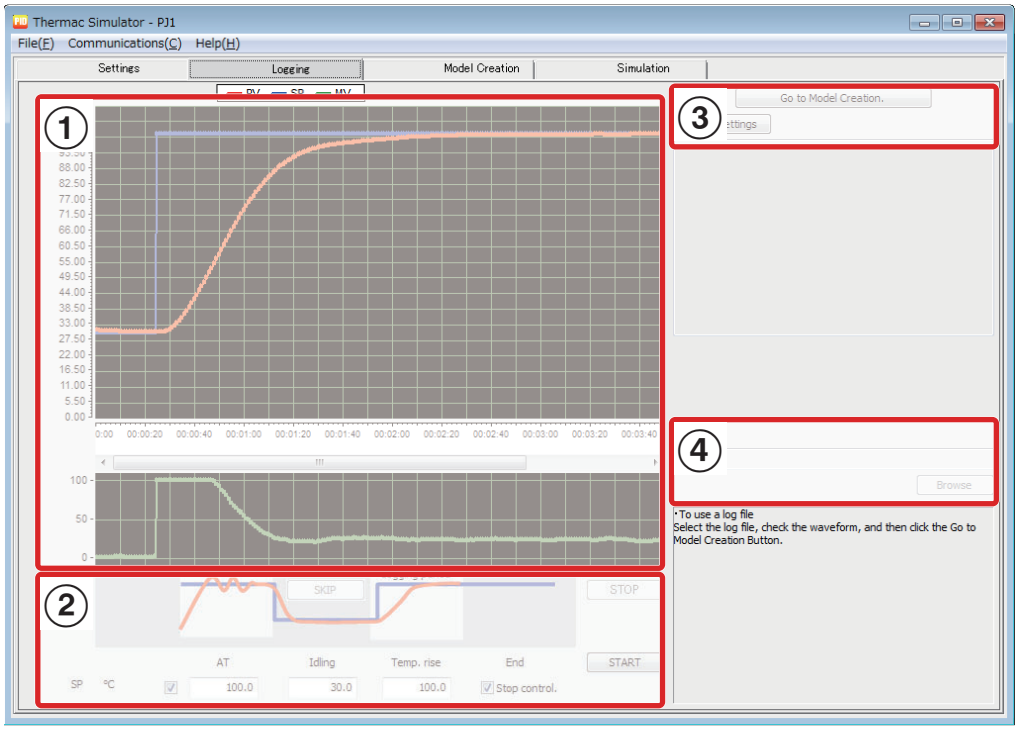


Set the parameters according to the following correlation table. Leave any parameters that are not being used at the default settings.

Parameter	SDC15/25/26 (Azbil Corporation)	RB□00 (RKC Instrument Inc.)
Input Type	Set the PV Range Type parameter to a close value.	Set the Input Range parameter to a close value.
Temperature Unit	Temperature Unit	Default (Use the default setting.)
Integral/Derivative Time Unit	Default (Use the default setting.)	
Proportional Band	Proportional Band (converted to temperature units)	Proportional Band (Heat-Side)
Integral Time	Integral Time	Integral Time
Derivative Time	Derivative Time	Derivative Time
Alpha	Default (Use the default setting.)	
MV Upper Limit	MV High Limit	Output Limiter High
MV Lower Limit	MV Low Limit	Output Limiter Low
SP Ramp Time Unit	SP Ramp Unit	Setting Change Rate Limiter Unit Time
SP Ramp Set Value	SP Ramp-Up	Setting Change Rate Limiter Up
SP Ramp Fall Value	SP Ramp-Down	Setting Change Rate Limiter Down

3-2 Logging Tab Page

This tap page is used to collect the log data that is required to create a model.
The tab page configuration is shown below.



①	Displays the process value (PV), set point (SP), and manipulated variable (MV).
②	Used to set the logging conditions.
③	Used to set the graph scales. Also, used to move to the Model Creation Tab Page.
④	Used to read log data from another company.

Log data is collected or a log file is read for the following cases. The processing for each case is given below.

Case 1: Using a New Controller and Case 2: Using a Previously Set Controller
Used to log data to use in creating a model.

Case 3: Using a Log File from Another Company
Used to read an existing log file.

3-2-1 Collecting Log Data

Use the following procedure to collect the log data.

1 Make the settings for autotuning (AT).

Select or clear the *AT* Check Box according the cases given in the following table.

Case	AT Check Box	Remarks
Using a New Controller	Select the check box (execute AT).	• If autotuning cannot be performed due to the characteristics of the controlled device, clear the selection of the check box. • If you changed the PID constants on the Settings Tab Page, clear the selection of the check box.
Using a Previously Set Controller	Clear the selection (do not execute AT).	To execute autotuning again, select the check box.

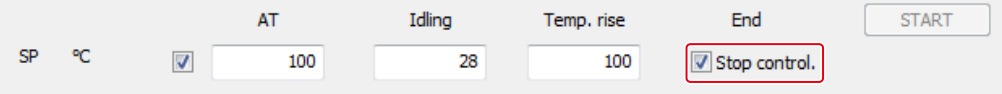
2 Set the set points.

Set the set points according to the following table.

Phase	Setting
AT	Set this set point if you selected the AT Check Box. Set the same value as for temperature rise. However, if the temperature fluctuation range during autotuning is a problem, set the value according to the allowable fluctuation range.
Idling	(SP for temperature rise – Normal temperature) × 10% + Normal temperature Example: SP for temperature rise = 100°C and Normal temperature = 20°C (100 – 20) × 0.1 + 20 = 28
Temp. rise	Set the set point at which the temperature is to be controlled.

3 Set the operation to perform after the completion of logging.

To continue control operation even after logging has been completed, clear the selection of the *Stop control* Check Box. If you select this check box, operation will be stopped.

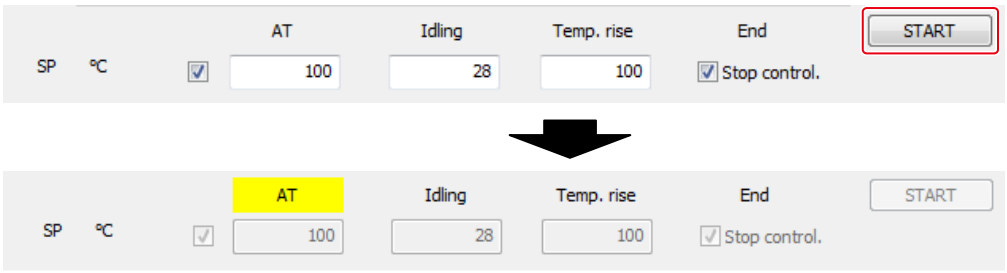


4 Click the START Button to start logging.

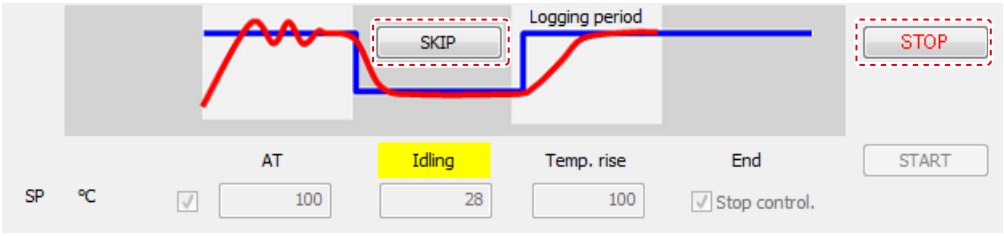
A confirmation message will be displayed. Click the **OK** Button.

There are four phases to logging: AT, idling, temperature rise, and end. Refer to *4 Appendix* (page 4-1) for the conditions to move between the phases.

The logging time is 60,000 s (approx. 17 hours) maximum. If the maximum value is exceeded, logging will stop according to the setting of the *Stop control* Check Box.

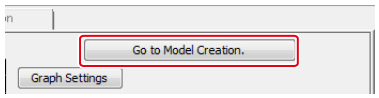


- To cancel logging, e.g., when unexpected temperature rise occurs, click the **STOP** Button.
- If too much time is required for the temperature to stabilize in the idling phase, you can click the **SKIP** Button to force a move to the temperature rise phase. If too much time is required for the temperature to stabilize in the temperature rise phase, you can click the **STOP** Button to force a move to the end phase. If you use either of these buttons, however, the deviation will increase for model creation.



5 Stop logging.

When logging is stopped, end phase is entered.
Click the **Go to Model Creation** Button to go to the Model Creation Tab Page.



3-2-2 Reading a Log File from Another Company

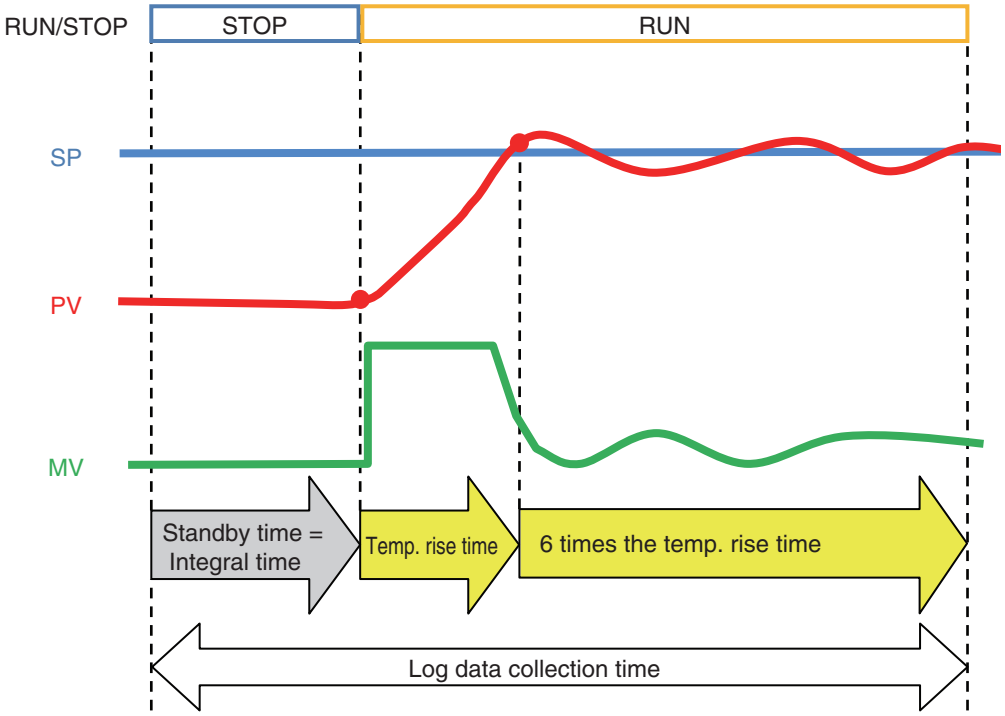
A log file that was created with one of the following software applications can be read.

Temperature Controllers	Application
SDC15/25/26 (Azbil Corporation)	SLP-C35 Smart Loader Package
RB□00 (RKC Instrument Inc.)	PROTEM2

Use the following procedure to create and read a log file from another company.

1 Create a log file from another company.

Create a log file that has the type of waveform as the one shown in the following figure.
Before log data collection, remain in STOP status until the PV stabilizes at the normal temperature.



Collect log data according to the information in the following table and create a log file.

Application	SLP-C35 Smart Loader Package	PROTEM2
Data	1: PV 2: MV 3: SP	Measured Value (PV) Monitor Manipulated Output Value (MV1) Monitor (Heat-Side): MV Set Value 1 (SV1): SV1
Time Period	1 s (High-speed trend: Not used.)	1 s (Cycle time: 1 s)

However, if you use a log file from another company, the PV will change stepwise when control starts from a stopped state. This will tend to cause more deviation when the model is created in comparison with using log data collection. For some Temperature Controllers, the MV may be less than 0.0% in STOP status. If this occurs, a model cannot be created correctly. Overwrite all MVs that are lower than 0.0% with 0.0% and then create the model.

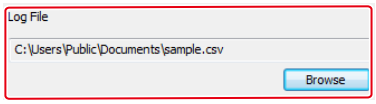
2 Read the log file.

Use the following procedure to read the log file.

(1) Select the log file.

Click the **Browse** Button to display a dialog box to select the log file, and select the log file.

The selected name will be displayed.

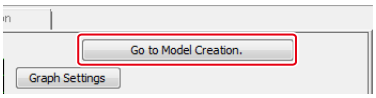


(2) Check the waveform for the file.

The log waveforms for the process value (PV), set point (SP), and manipulated variable (MV) will be displayed. To change to a different log file, select the log file again.

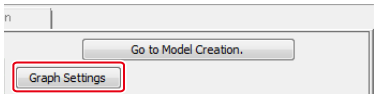
(3) Move to the Model Creation Tab Page.

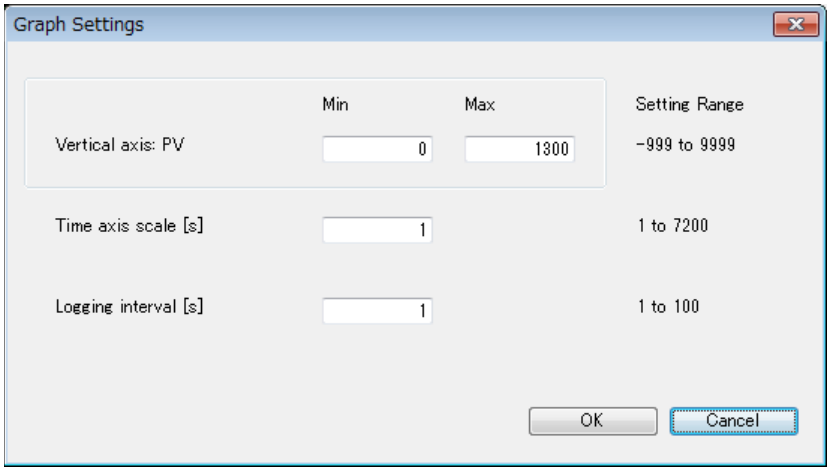
Click the **Go to Model Creation** Button to go to the Model Creation Tab Page.



3-2-3 Adjusting the Graph Scales

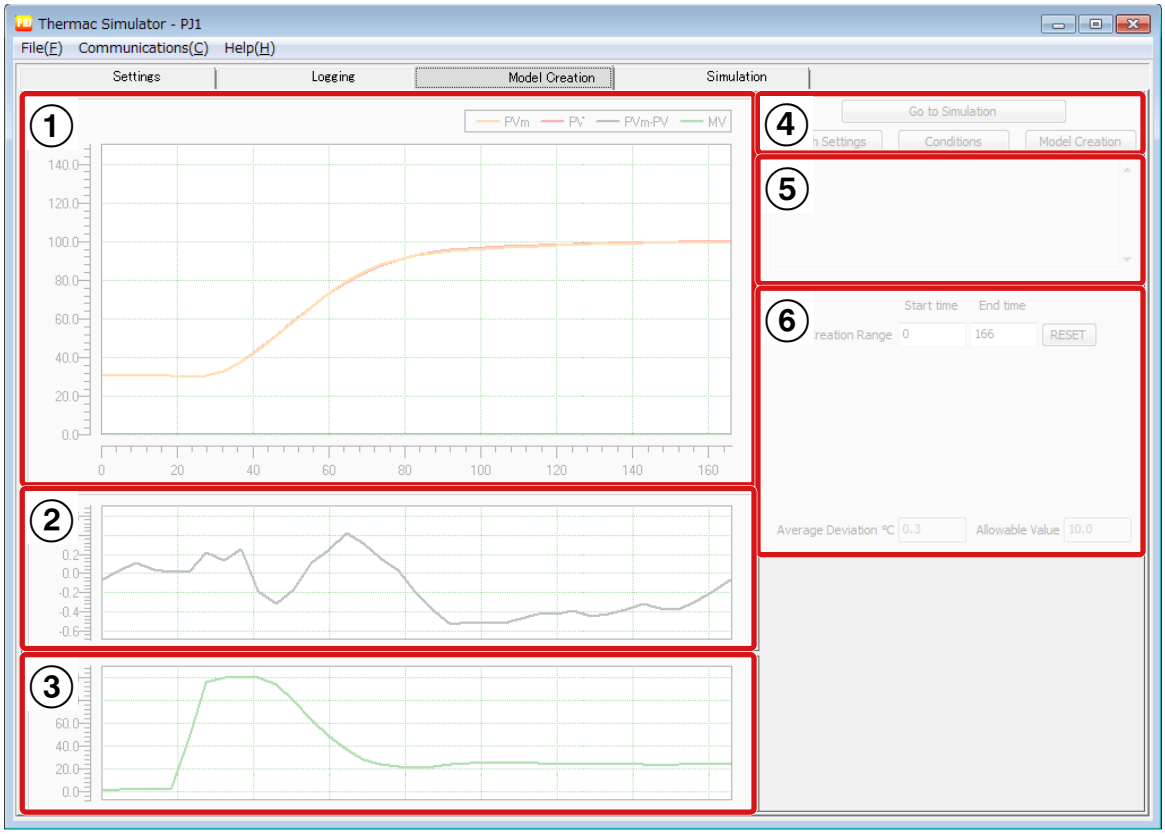
To change the graph scales, click the **Graph Settings** Button to display the following dialog box and adjust the required items. When you are finished making changes, click the **OK** Button. If you close the dialog box by clicking the **Cancel** Button, any changes will be lost. You cannot change the time axis scale or logging interval while logging is in progress.





3-3 Model Creation Tab Page

This tab page is used to create the model that is required for simulation. A model is a mathematical representation of the temperature characteristics of a device. It is created from the process values (PVs) and the values of the manipulated variable (MV). The tab page configuration is shown below.



①	Displays the waveform of logged process values (PVs) and the PVm waveform.*1
②	Displays the deviation as a waveform.*1, *2
③	Displays the waveform of logged values of the manipulated variable (MV).
④	Used to create the model. Also used to move to the Simulation Tab Page.
⑤	Displays error messages.
⑥	This waveform is not displayed until the model is created.*1, *2

*1 PVm: Values calculated from the model
Deviation: The difference between PV and PVm
Average Deviation: The absolute values of the differences between PV and PVm averaged over time.

*2 This waveform is not displayed until the model is created.

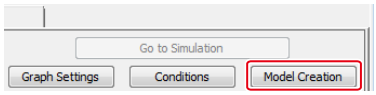
3-3-1 Creating the Model

1 **Check the log waveform that will be used to create the model.**

The waveforms of the logged process values (PVs) and values of the manipulated variable (MV) that were selected on the Logging Tab Page are displayed.

2 **Start model creation.**

Click the **Model Creation** Button to start creation of the model.



A progress bar will be displayed to show the progress of model creation.

The longer the logging time was, the more time will be required for model creation.

3 **If model creation is completed successfully, the Simulation Tab Page will be displayed automatically.**

Refer to *3-4 PID Simulation* (page 3-13) for operating procedures on the Simulation Tab Page.

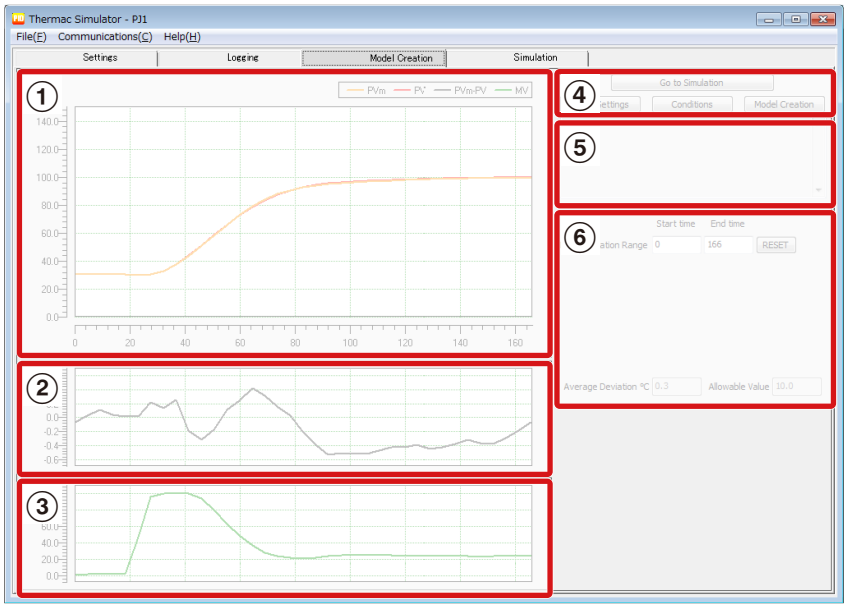
4 **If the model could not be created, the following will be displayed.**

① The PVm values calculated from the model will be added and the model creation range (i.e., the area that is not grayed out) will be displayed.

② The deviations between PV and PVm will be displayed.

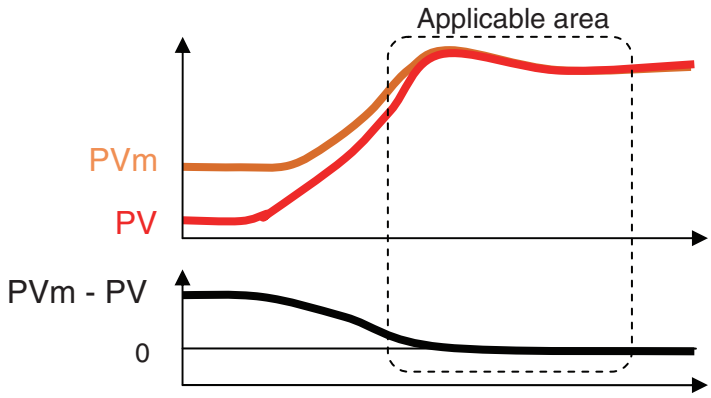
⑤ An error message will be displayed.

⑥ The model creation range and average deviation will be displayed.

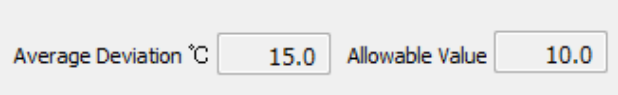


Use the following information to troubleshoot the problem.

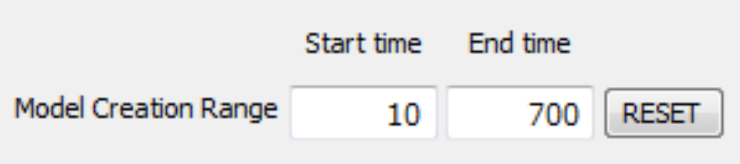
Error message	Cause	Correction
If the average deviation is allowable, go to the simulation. If it is not allowable, log the data again.	The average deviation exceeded the allowable value.	If the deviation shown in the applicable area in the following figure is minimal, click the **Go to Simulation** Button to move to the Simulation Tab Page.
An unstable model was created. Log the data again.	Correct log data was not collected.	Check the log waveform to see if it is wrong. Refer to *3-2 Logging Tab Page* (page 3-5) for details.



The absolute average deviation is displayed. If it exceeds the allowable value, an error will occur.



Do not change the model creation range. You can restore the original values by clicking the **RESET** Button.

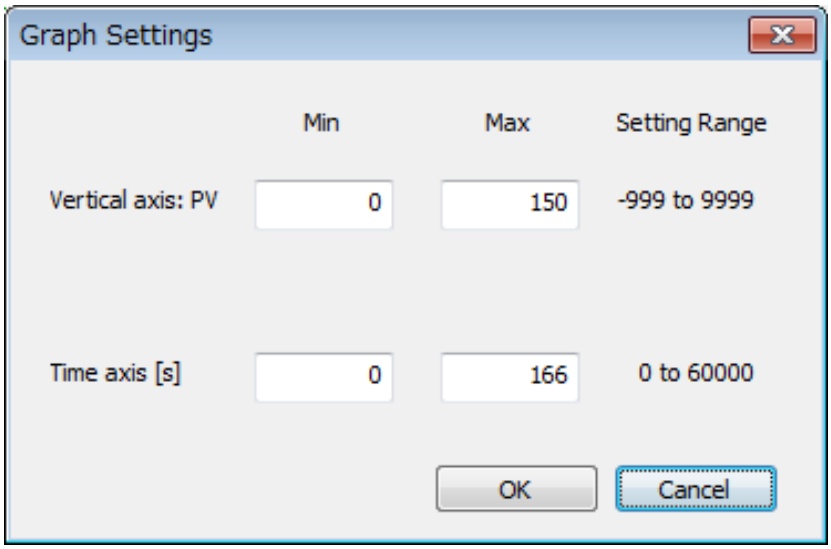


Additional Information

The conditions for creating the model will be displayed if you click the **Conditions** Button. Use the default values.

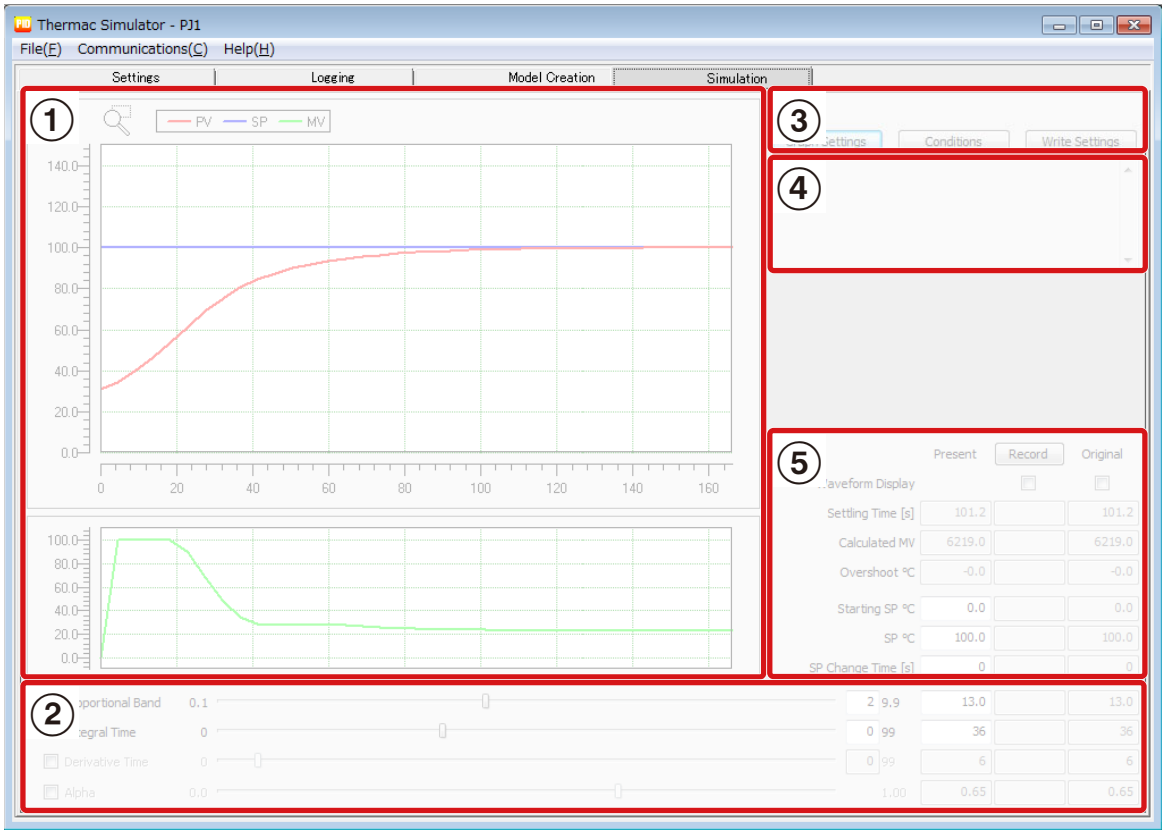
3-3-2 Adjusting the Graph Scales

To change the graph scales, click the **Graph Settings** Button to display the following dialog box and adjust the required items. When you are finished making changes, click the **OK** Button. If you close the dialog box by clicking the **Cancel** Button, any changes will be lost.



3-4 PID Simulation

The Simulation Tab Page is used to simulate a PV waveform.
The tab page configuration is shown below.



①	Displays the process value (PV), set point (SP), and manipulated variable (MV).
②	Used to change the PID constants and alpha value. The simulation waveform is updated whenever a value is changed.
③	Used to set the graph scales and simulation conditions. Also used to write the adjusted set values to the Temperature Controller.
④	Displays error messages and other messages during operation.
⑤	Displays information on the simulation waveform and used to change the set point (SP). Can also be used to record the waveform and to compare a recorded waveform with the waveform that is currently being adjusted.

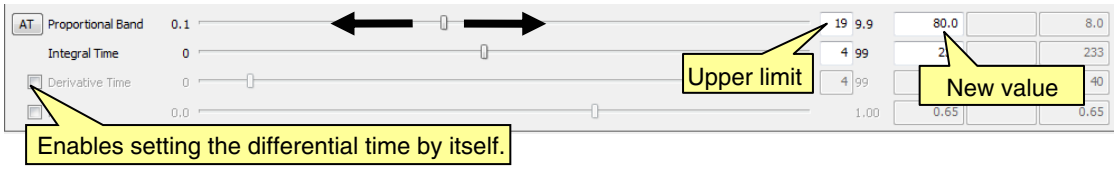
3-4-1 Adjusting the PID Constants

You can change the PID constants and then simulate the PV waveform.

1 Changing the Proportional Band (P)

Move the slider bar to the left or right to change the value. The new value is displayed to the right of the bar. You can also input the value directly in the box on the right of the bar.
You can set the upper limit of the bar in the upper limit box to the right of the bar. Enter the third and forth digits of the upper limit of the bar.

Example: To specify an upper limit of 199.9 for the bar, enter “19”.



2 Changing the Integral Time (I)

The procedure is essentially the same as for the proportional band.

3 Changing the Derivative Time (D)

By default, the derivative time is set automatically according to the value of the integral time. Select the check box to change the derivative time by itself. The procedure is essentially the same as for the proportional band.

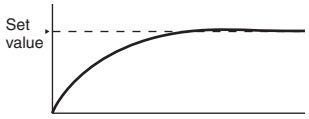
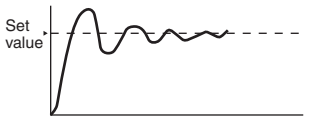
Parameter	Setting range
P	0.1 to 999.9
I and D	Integral/derivative time unit = 1 s: 0 to 9,999 Integral/derivative time unit = 0.1 s: 0.0 to 999.9

* If the integral time is 0, the manual reset value is processed with the following values.
Previously set Temperature Controller: Set value of the parameter from Temperature Controller
Other cases: 50.0%

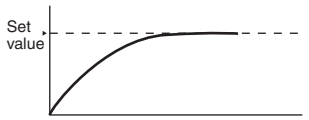
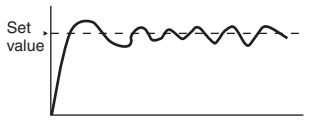
Additional Information

The following tables describe the trends in the PV waveforms for changes in the PID constants.

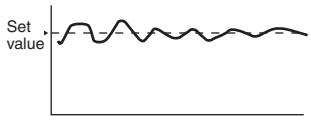
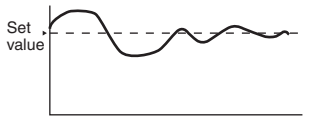
When the Proportional Band (P) Is Adjusted

Increased		The curve rises gradually, and a long stabilization time is created, but overshooting is prevented.
Decreased		Overshooting and hunting occur, but the set value is quickly reached and the temperature stabilizes.

When the Integral Time (I) Is Adjusted

Increased		It takes a long time to reach the set point. It takes time to achieve a stable state, but overshooting, undershooting, and hunting are reduced.
Decreased		Overshooting and undershooting occur. Hunting occurs. The Temperature Controller starts up faster.

When the Derivative Time (D) Is Adjusted

Increased		Overshooting, undershooting, and stabilization times are reduced, but fine hunting occurs on changes in the curve itself.
Decreased		Overshooting and undershooting increase, and it takes time to return to the set point.

3-4-2 Executing Autotuning (AT)

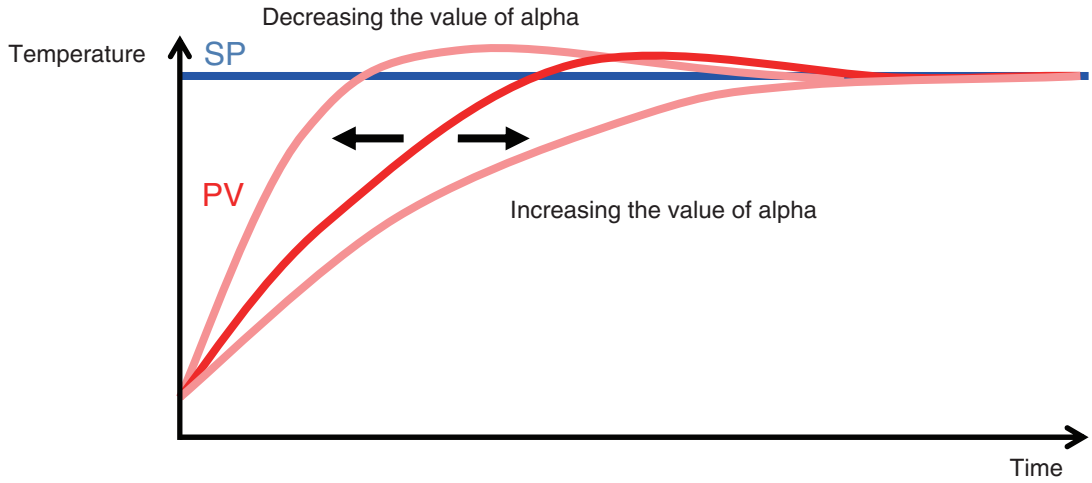
You can perform autotuning during a simulation. This is useful when autotuning cannot be performed for the actual system or when it is difficult to set the PID constants properly. Click the **AT** Button to execute autotuning.

A message is displayed during autotuning and the PID constants are updated when it is completed. An error message is displayed in the message area if autotuning is canceled or an error occurs.

3-4-3 Adjusting the Rising Portion of the PV Waveform

You may be able to improve the rising portion of the PV waveform by adjusting alpha. Select the check box to change alpha. The procedure is essentially the same as for the proportional band.

Alpha	Effect
Decreasing the value	The rising time is reduced. However, overshooting will become larger.
Increasing the value	Overshooting will be suppressed. However, the rising time will increase.



3-4-4 Changing the Set Point

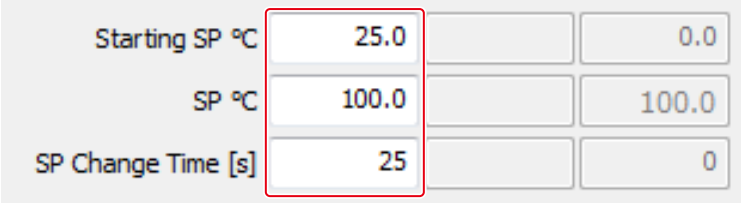
You can change the set point and then perform a simulation. You can also set the original set point (the starting SP) and the timing for changing the set point.

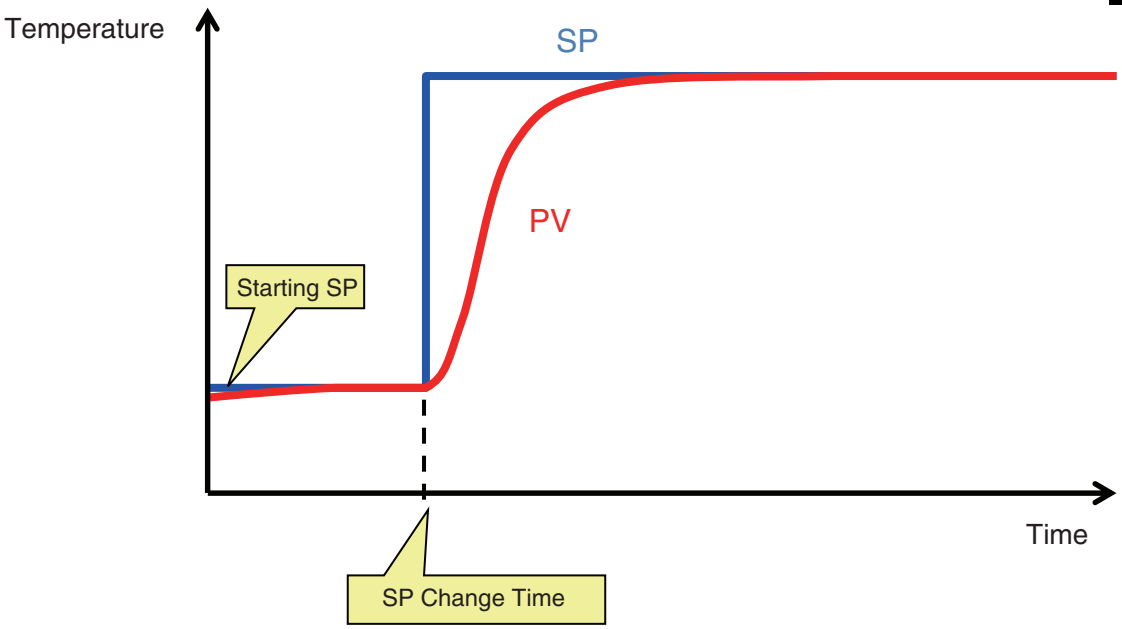
(1) Changing the Set Point

The following text boxes are used to change the set point.

(2) Changing the Starting SP

Set the starting SP and the SP change time as required.





Parameter	Setting range
Starting SP	Same as temperature range of the input type
SP *	
SP Change Time	0 to 60,000

*If you use a log file from another company, the last PV in the log data is used as the SP.

3-4-5 Comparing Waveforms during Adjustment

You can save a waveform temporarily during adjustment and then compare it with the waveform after adjustment is completed. You can also perform comparisons with the original waveform from the start of simulation. The procedure and waveform display examples are given below.

(1) Temporarily Saving a Waveform

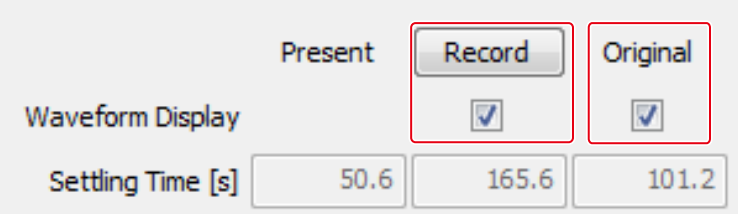
Click the **Record** Button to temporarily save the present waveform.

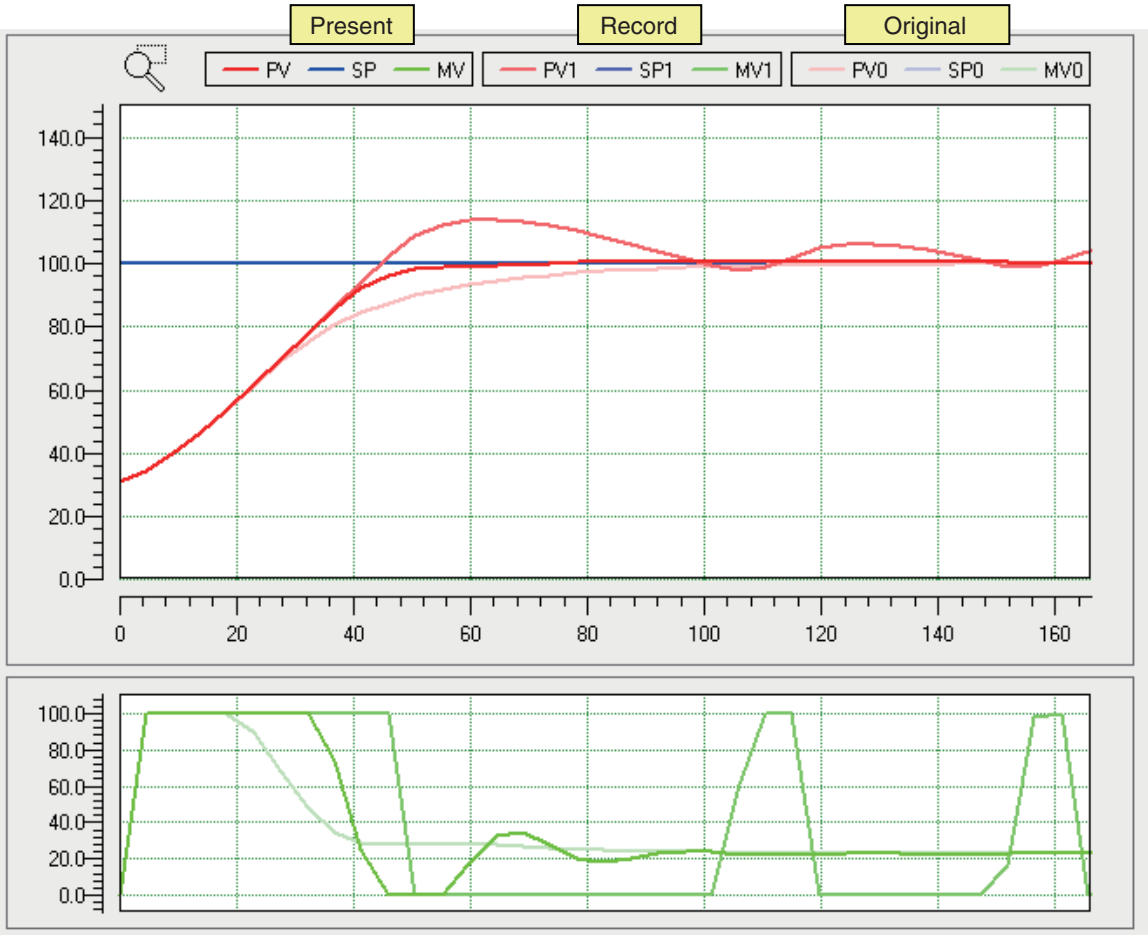
(2) Comparison with the Temporarily Saved Waveform

Select the check box below the **Record** Button to display the temporarily saved waveform.

(3) Comparison with the Original Waveform

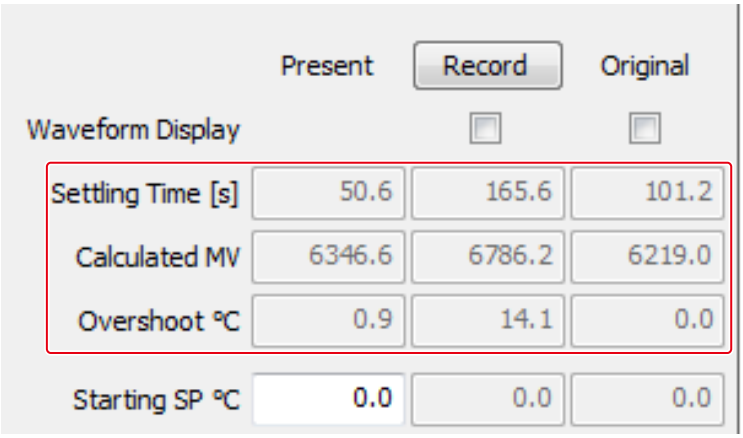
Select the check box below the **Original** label to display the original waveform from the start of simulation.





3-4-6 Checking Waveform Information

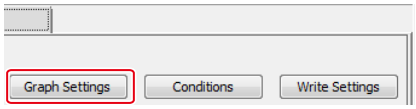
You can check the settling time and overshoot with the following text boxes. You can also check the same information for the recorded and original waveforms.

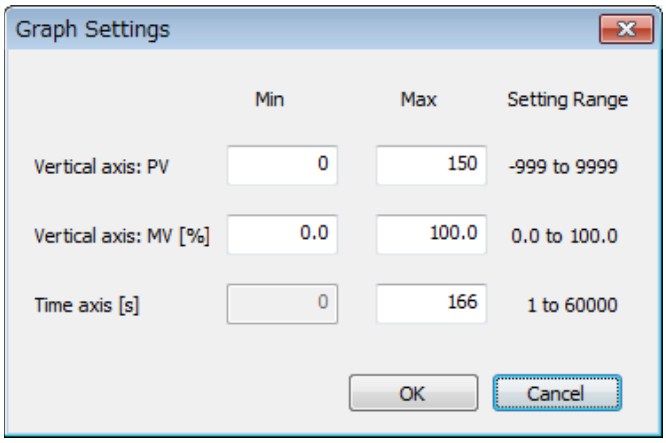


Item	Description
Settling Time	The settling time is the time required for the PV to stabilize within the settling width of the SP. Refer to the *3-4-9 Changing Simulation Conditions* (page 3-21) for information on the settling width.
Calculated MV	The calculated value of the MV in the MV waveform is given. You can also specify converting the value to the power consumption. Refer to the *3-4-9 Changing Simulation Conditions* (page 3-21) for information on power consumption.
Overshoot	The amount by which the PV overshoots the SP in the rising portion of the PV waveform is displayed.

3-4-7 Adjusting the Graph Scales

To change the graph scales, click the **Graph Settings** Button to display the following dialog box and adjust the required items. When you are finished making changes, click the **OK** Button. If you close the dialog box by clicking the **Cancel** Button, any changes will be lost.



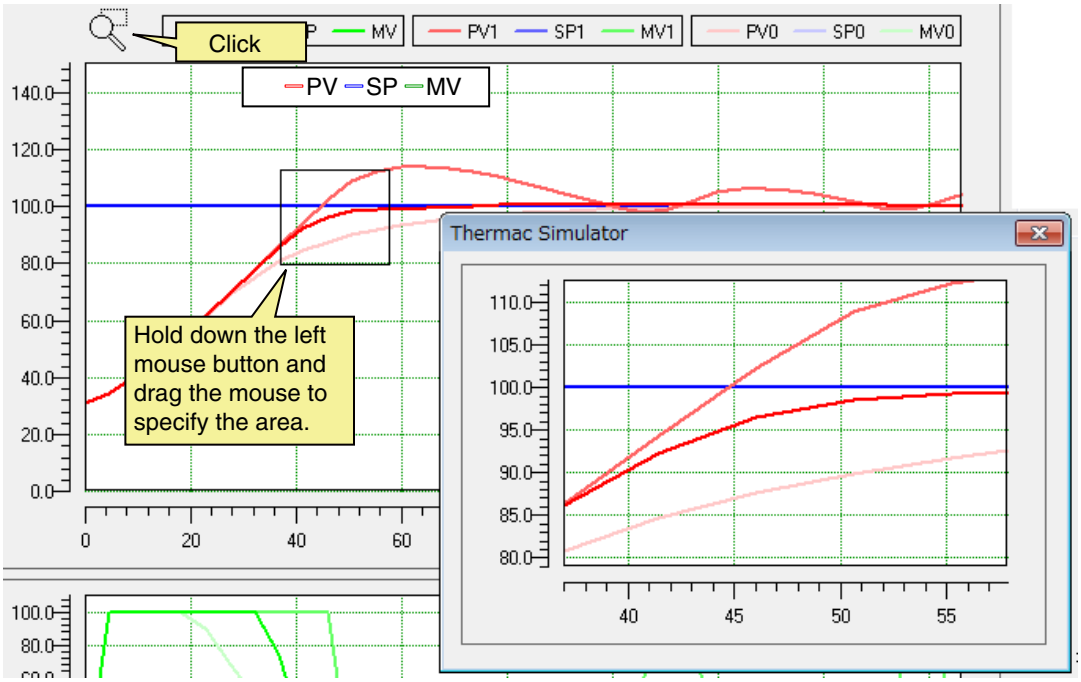


Additional Information

Simulation is performed for the maximum value of the time axis. If you change the time axis, the values in the Setting Time, Calculated MV (or power consumption), and Overshoot Boxes may change.

3-4-8 Enlarging the PV Waveform

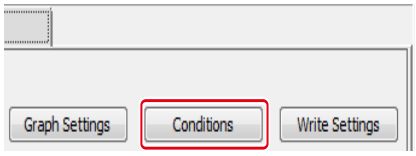
You can enlarge part of the PV waveform. Click the enlargement icon, hold down the left mouse button, and select the area to enlarge. The enlarged part of the waveform will be displayed when you release the left mouse button.

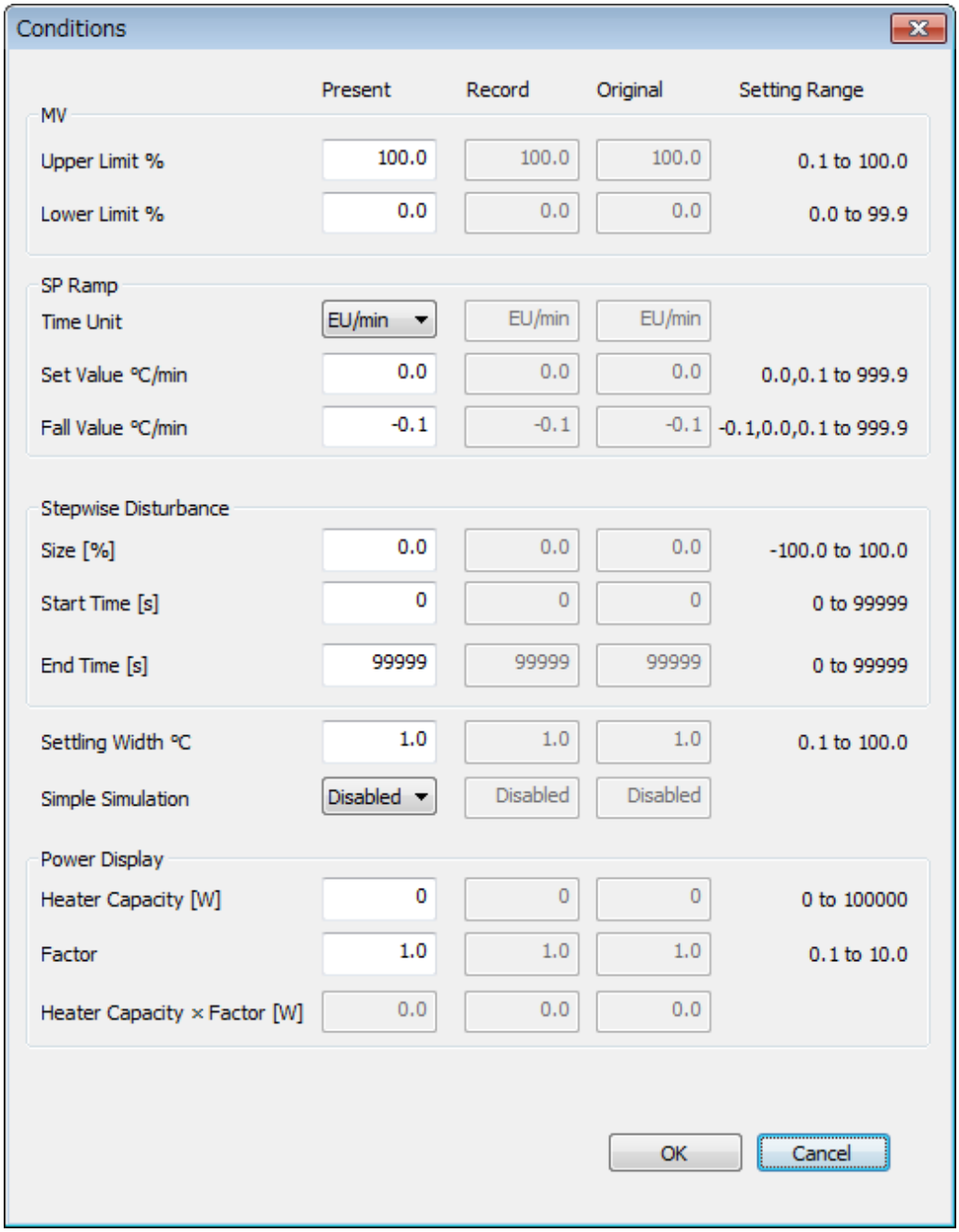


3-4-9 Changing Simulation Conditions

You can change the settings on the following dialog box.

Click the **Conditions** Button to display this dialog box, and then change the required items. When you are finished making changes, click the **OK** Button. If you close the dialog box by clicking the **Cancel** Button, any changes will be lost.





MV Area

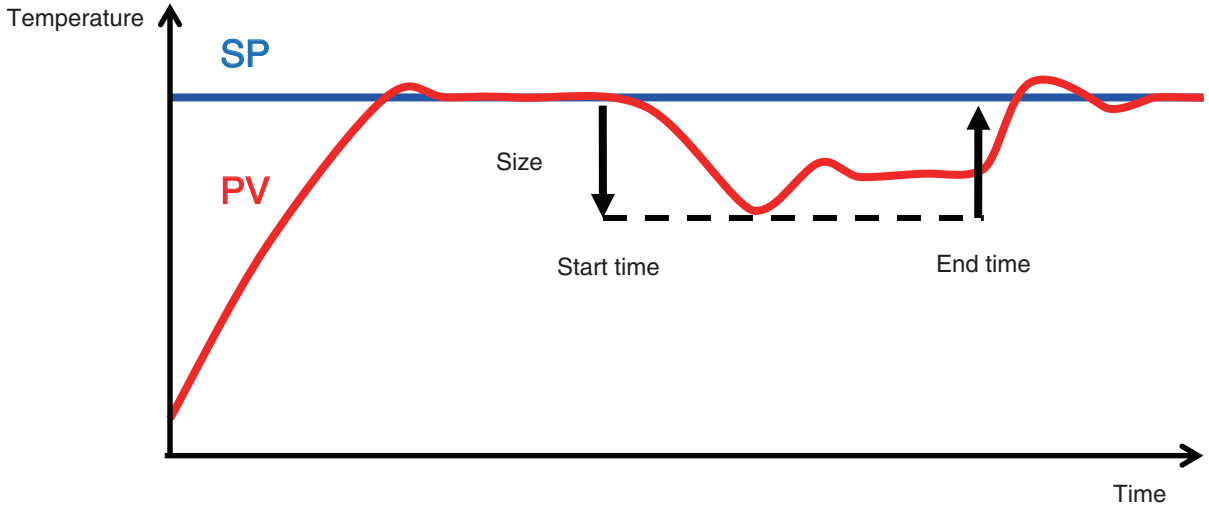
Use this area to set limits for the MV. Using limits may slow down the rising portion of the PV waveform and may result in overshooting. The defaults will be the values set on the Settings Tab Page.

SP Ramp Area

You can set an SP ramp to gradually increase and decrease the SP to prevent rapid changes in the PV at the start of a simulation. Set the change width per time unit to set the SP ramp. Set the time unit in the *Time Unit* Box. Set the change width for temperature rise in the *Set Value* (SP Ramp Set Value) Box and the change width for temperature fall in the *Fall Value* (SP Ramp Fall Value) Box. The defaults will be the values set on the Settings Tab Page.
The following settings can be used.
You can set the SP Ramp Set Value or SP Ramp Fall Value parameter to 0 or 0.0 to disable the function.
You can set the SP Ramp Fall Value parameter to –1 or –0.1 to use the same set value as the SP Ramp Set Value parameter.

Stepwise Disturbance Area

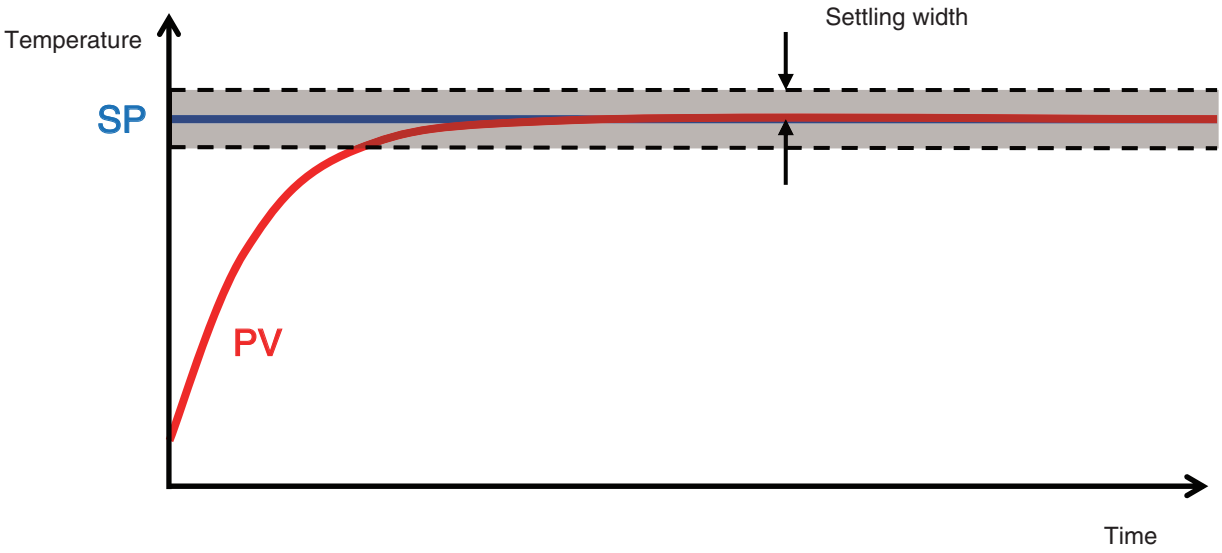
You can simulate a disturbance in the simulation waveform.
To set the disturbance, set the *Size*, *Start Time*, and *End Time* Boxes. Check the change width in the PV caused by the disturbance before you make the settings.
If you set the end time longer than the simulation waveform, it will act like stepwise disturbance.



The above figure is merely an illustration. “Size,” “Start time,” and “End time” are not actually displayed on the waveform.

Settling Width

You can set the settling width that is used to calculate the settling time. Refer to *3-4-6 Checking Waveform Information* (page 3-19) for information on the settling time.



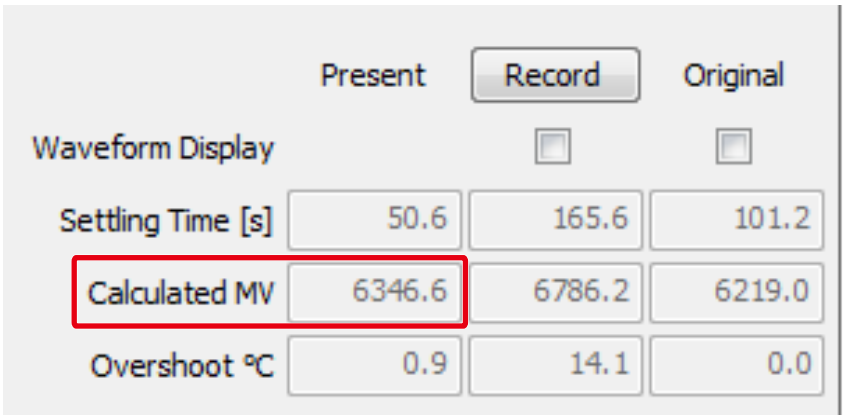
Simple Simulation

You can use a simple simulation if too much time is required for a normal simulation. The simulation time is reduced by increasing the calculation period used for simulation. This will result in lower accuracy. Select *Enabled* for the Simple Simulation parameter to perform a simple simulation.

Power Display Area

You can display an approximation of the power consumption based on the heater capacity used in temperature control. Use this as a guideline for checking the efficiency of saving energy. If you display the power consumption, enter the heater capacity in the *Heater Capacity* Box. Refer to *3-4-6 Checking Waveform Information* (page 3-19) for information on the display.

Heater Capacity	Display
0	The calculated MV is displayed.
Any setting except for 0	The power consumption is displayed.



Changing the Heater Capacity for a Simulation

You can change the heater capacity and then perform a simulation. Enter values for the *Heater Capacity* and *Factor* Boxes.

If you do not know the heater capacity, enter 1 for the factor. (The correct power consumption will not be displayed.)

Example: To reduce the heater capacity by half, set the factor to 0.5.

You can confirm the new heater capacity by multiplying the heater capacity by the factor. If you have changed the heater capacity in this way, “The heater capacity is being changed” will be displayed in the message area.

Also, if you have changed the heater capacity in this way, the **Write Settings** Button will be disabled and you will not be able to write the settings. To enable the **Write Settings** Button, set the factor to 1.0.

Precautions for Correct Use

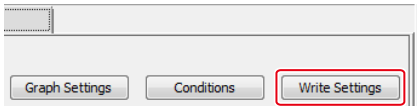
Even if you execute autotuning with the heater capacity factor set to a value other than 1.0, the PID constants will be calculated with a factor of 1.0.

Refer to *3-4-2 Executing Autotuning (AT)* (page 3-15) for information on autotuning.

3-4-10 Writing the Simulation Results to the Temperature Controller

Connect the Temperature Controller to the computer with a USB-Serial Conversion Cable.

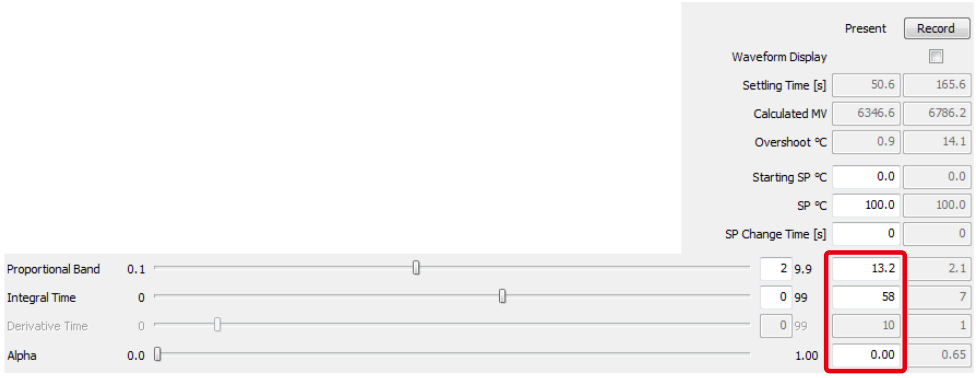
Click the **Write Settings** Button to write the adjusted set values to the Temperature Controller.

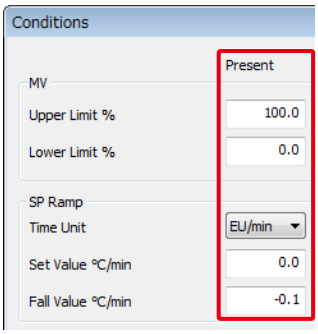


The following present values, indicated in the following figure, will be written.

- Proportional band, integral time, derivative time, and alpha
- MV upper limit and MV lower limit
- SP ramp time unit, SP ramp set value, and SP ramp fall value*

* The value of the *Set Value* parameter is written for the SP Ramp Set Value parameter and the value of the *Fall Value* parameter is written for the the SP Ramp Fall Value parameter.


Present
Record
Waveform Display
Settling Time [s] 50.6 165.6
Calculated MV 6346.6 6786.2
Overshoot °C 0.9 14.1
Starting SP °C 0.0 0.0
SP °C 100.0 100.0
SP Change Time [s] 0 0
Proportional Band 0.1 2 9.9 13.2 2.1
Integral Time 0 0 99 58 7
Derivative Time 0 0 99 10 1
Alpha 0.0 1.00 0.00 0.65

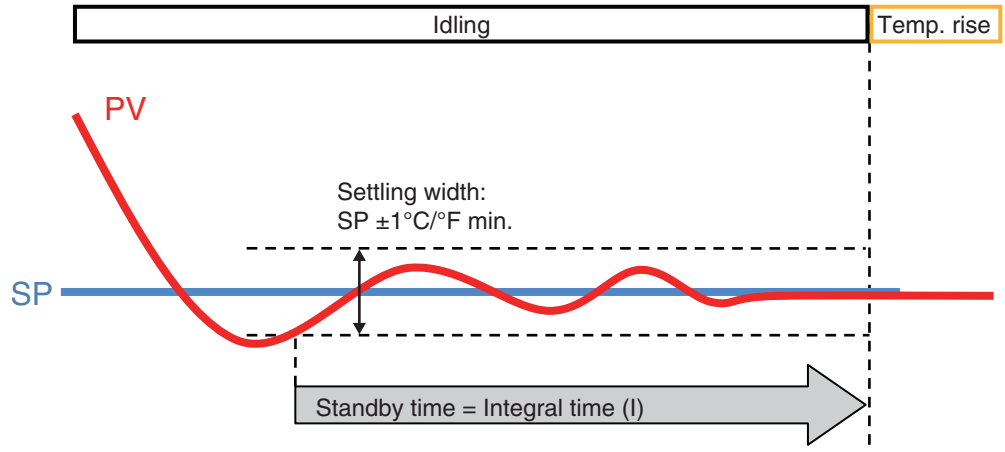


4 Appendix

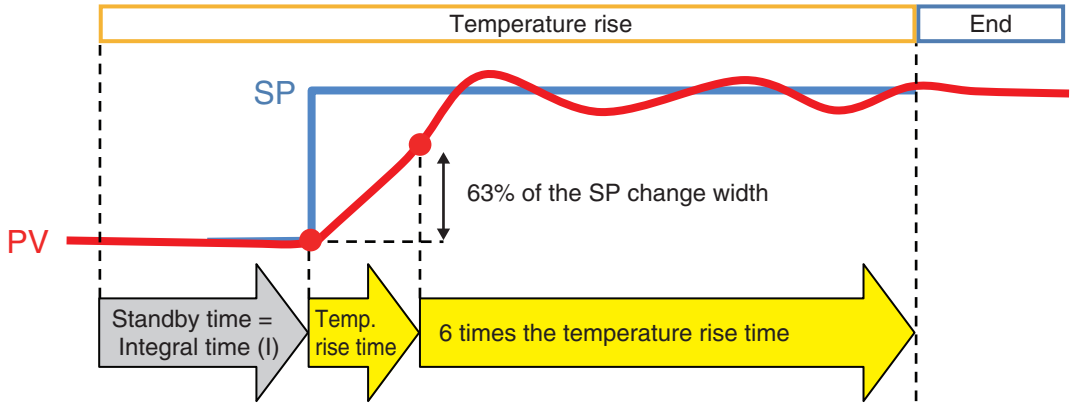
Phase Changes during Log Data Collection

The conditions for moving between the idling, temperature rise, and end phases that are described in *3-2-1 Collecting Log Data* (page 3-6) are as follows:

- Condition for Moving from Autotuning to Idling
  The idling phase is entered when autotuning is completed normally or after autotuning has been performed for 20,000 s.
- Condition for Moving from Idling to Temperature Rise
  The temperature rise phase is entered if the PV does not exceed the settling width during the standby time, as shown in the following figure.



- Condition for Moving from Temperature Rise to End
  The end phase is entered when seven times the temperature rise time plus the standby time has elapsed, as shown in the following figure.



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